TECHNICAL STAFF REPORT

PROPOSED AMENDMENTS TO THE WATER QUALITY CONTROL PLAN FOR THE LAHONTAN REGION

Removal of the Municipal and Domestic Supply (MUN) Beneficial Use Designation from Surface Waters of Owens Lake, Inyo County

California Regional Water Quality Control Board
Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe CA 96150
(530) 542-5400
http://www.waterboards.ca.gov/lahontan

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Contact Person:

Judith Unsicker
Staff Environmental Scientist
Phone: (530) 542-5462
Fax: (530) 542-5470
Email: junsicker@waterboards.ca.gov

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Executive Summary

This staff report provides the technical justification for amendment of the *Water Quality Control Plan for the Lahontan Region* (Basin Plan) to remove the Municipal and Domestic Supply (MUN) beneficial use designation from all perennial and ephemeral surface waters of Owens Lake. The Basin Plan amendments would also clarify the application of the MUN use to wetlands above and below the historic shoreline of the lake. The MUN use would not be removed from ground water underlying and surrounding the lakebed or from streams, springs and wetlands above the historic shoreline. No changes are proposed to other designated beneficial uses of Owens Lake.

This staff report summarizes information and data on hydrology and water quality at Owens Lake. It concludes that the MUN use is not an existing use of the affected surface waters, and cannot feasibly be attained through permit conditions, use of Best Management Practices, or treatment such as desalination. Due to water quality and water quantity considerations, removal of the MUN use from surface waters of Owens Lake is justified under criteria in the federal Water Quality Standards Regulation (40CFR 131.10 (g)) and California's Sources of Drinking Water Policy (State Water Resources Control Board Resolution 88-63).

These amendments would allow the Lahontan Regional Board to consider granting an exemption from the Basin Plan's regionwide prohibition against industrial waste discharges to surface waters for a mining waste discharge to the Owens Lake brine pool. The absence of a MUN use designation will also change the applicability of certain existing state and federal water quality standards, and the applicability of the Proposition 65 prohibition against discharges of toxic substances, to surface waters of Owens Lake. This could affect Regional Board permitting and enforcement activities for other discharges to surface waters on the lakebed.

1. Introduction

The Lahontan Regional Water Quality Control Board (Regional Board) is the California state agency that sets and enforces water quality standards in about 20 percent of the state including the eastern Sierra Nevada and northern Mojave Desert. Water quality standards and control measures for surface and ground waters of the Lahontan Region are contained in the *Water Quality Control Plan for the Lahontan Region* (Basin Plan). California's standards include designated beneficial uses, narrative and numeric water quality objectives for protection of beneficial uses, and a non-degradation policy. Existing state standards for Owens Lake, its tributaries, and the Owens Valley ground water basin can be found in Chapters 2 and 3 of the Lahontan Basin Plan. The plan is available online at http://www.waterboards.ca.gov/lahontan. The U.S. Environmental Protection Agency (USEPA) has also promulgated standards for certain toxic pollutants in surface waters of California. This staff report provides the technical justification for proposed Basin Plan amendments to remove the Municipal and Domestic Supply (MUN) beneficial use designation from the surface waters of Owens Lake in Inyo County (Figure 1). The potential environmental and socioeconomic impacts of this change are addressed in a separate California Environmental Quality Act (CEQA) document.

2. Scope of the Proposed Amendments

The Municipal and Domestic Supply (MUN) beneficial use is defined in Chapter 2 of the Basin Plan as: "Beneficial uses of waters used for community, military, or individual water supply systems including, but not limited to drinking water supply." Components of the MUN use other than human drinking water supply could include water supplies for pets and home aquaria, bathing, laundry and dishwashing, toilet flushing and landscape watering. California state drinking water standards apply to ambient waters with designated MUN uses, as well as to treated water in water supply and distribution systems. The Regional Board designated the MUN use for surface waters of Owens Lake in 1989 as part of a "blanket" designation of the use for most waters of the Lahontan Region. More information on this designation is provided in Section 6.A. of this staff report.

The proposed amendments would change Table 2-1 in the Basin Plan, "Beneficial Uses of Surface Waters of the Lahontan Region" to remove the "X" in the MUN beneficial use column for the "Owens Lake" row under the "Lower Owens HA" heading (HU No. 603.30). "HU" stands for "Hydrologic Unit" or watershed, and Hydrologic Units may be divided into "Hydrologic Areas" (HAs). The numbering system comes from watershed mapping by the California Department of Water Resources. The proposed amendments would also clarify the application of the MUN use to wetlands on and near Owens Lake. (If the amendments are approved, the MUN use will not apply to wetlands below the historic shoreline of the lake, at approximately 3,600 feet elevation.) Designated beneficial uses for the Lower Owens HA are shown on pages 2-26 through 2-28 of the current Basin Plan. The plan is being reformatted electronically to incorporate Basin Plan amendments approved since 1995, and page numbers may change in future editions.

No other changes in beneficial uses are proposed for Owens Lake or associated surface and ground waters as part of these Basin Plan amendments. No changes are proposed in water quality objectives for the surface waters affected by the use change. However, removal of the MUN use would change the applicability of some existing water quality objectives, as discussed in Section 6, below.

The surface waters of Owens Lake affected by the proposed amendments include: 1) the brine pool in the west central portion of the lakebed, 2) water that reaches the lakebed from the Owens River and tributary streams, 3) artesian wells, springs and seeps discharging to the lakebed and associated wetlands, 4) shoreline wetlands extending onto the lakebed, 5) ponds from direct precipitation on the lakebed, and 6) stormwater runoff. Some of these waters may be interconnected with each other during periods of high precipitation and runoff. Some, but not all of these waters have been formally

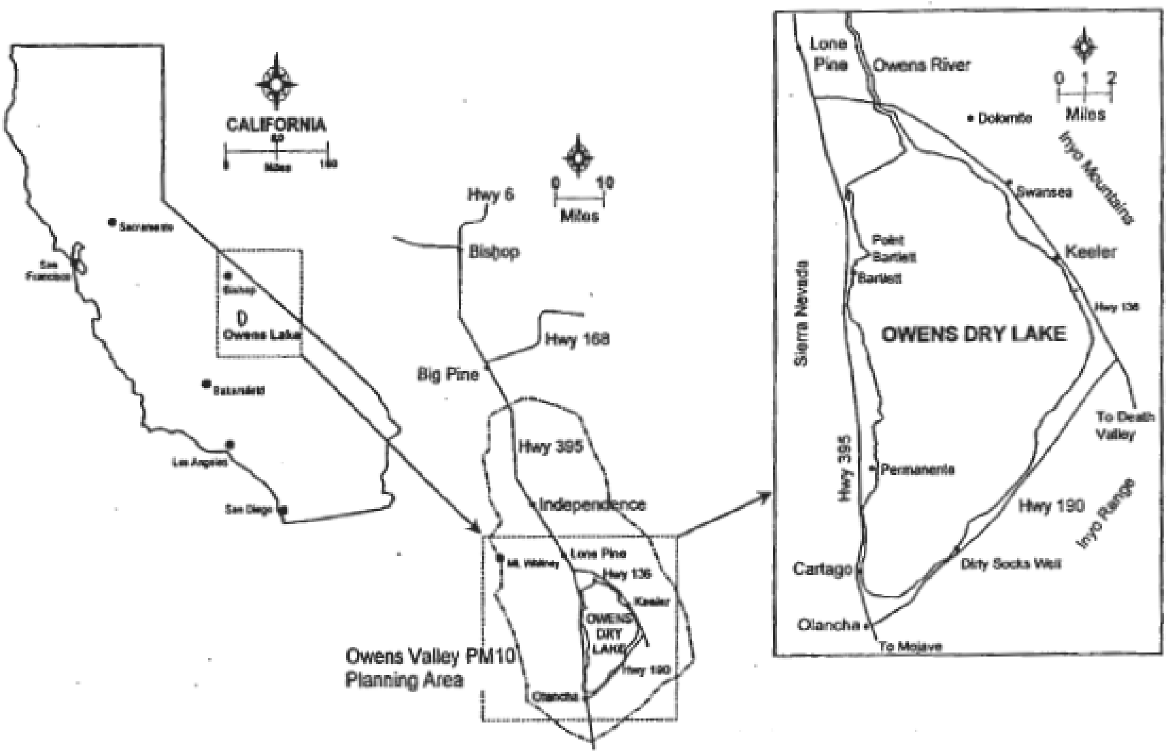

Figure 1. **Owens Lake Location Map** (Source: GBUAPCD, 1997)

delineated as waters of the United States by the U.S. Army Corps of Engineers. All surface waters of Owens Lake are considered waters of the State of California, and state water quality standards apply. See Figures 2, 3 and 4 for maps of the brine pool and wetlands.

The Lahontan Regional Board considered, but did not adopt, a different and larger group of Basin Plan amendments for Owens Lake in 1995. The earlier draft amendments included removal of the MUN use from the Owens Lake brine pool, but not from other surface waters. Some of the data used in the 1995 planning process have been used in development of the currently proposed amendments. However, the draft 2005 amendments should be considered a separate project.

3. Purpose of and Need for Amendments

The primary reason for proposing removal of the MUN use at this time is to facilitate Regional Board permitting for a U.S. Borax discharge of brine mining wastes to the Owens Lake brine pool. On September 9, 2004, the Regional Board adopted Board Order No. R6V-2004-0035 (WDID 6B140202001), "Waste Discharge Requirements for U.S. Borax, Inc. and California State Lands Commission, Owens Lake Ore Processing Operations" including Monitoring and Reporting Program No. 2004-0035. The acronym "WDRs" for "waste discharge requirements" will be used in references to Regional Board permits throughout this report. The WDRs for U.S. Borax cover discharges above the Ordinary High Water Mark of the brine pool, as defined by the U.S. Army Corps of Engineers. If the proposed Basin Plan amendment is approved, the Regional Board will consider revising the WDRs and adopting a concurrent federal National Discharge Elimination System (NPDES) permit to allow discharges below the Ordinary High Water Mark. U.S. Borax's operations at Owens Lake are summarized in Section 4.B., below.

The Lahontan Basin Plan prohibits most industrial waste discharges to surface waters. However, it allows industrial discharges to waters not designated for the MUN use, if appropriate antidegradation findings can be made and if the discharge meets the regionwide General Discharge Limitations for industrial and municipal discharges (see Section 4.7 of the Basin Plan). The Limitations require that discharges contain "essentially none" of a variety of toxic or otherwise deleterious substances.

By changing the applicability of existing water quality objectives associated with the MUN use, the proposed Basin Plan amendments would also affect Regional Board permitting and enforcement activities for all other discharges to surface waters of Owens Lake. The proposed U.S. Borax discharge is the only known industrial discharge to surface waters that would be facilitated by removal of the MUN use. Much of the Owens Lake bed outside of the brine pool is either occupied by or targeted for dust control or wildlife habitat enhancement projects that may involve surface water discharges.

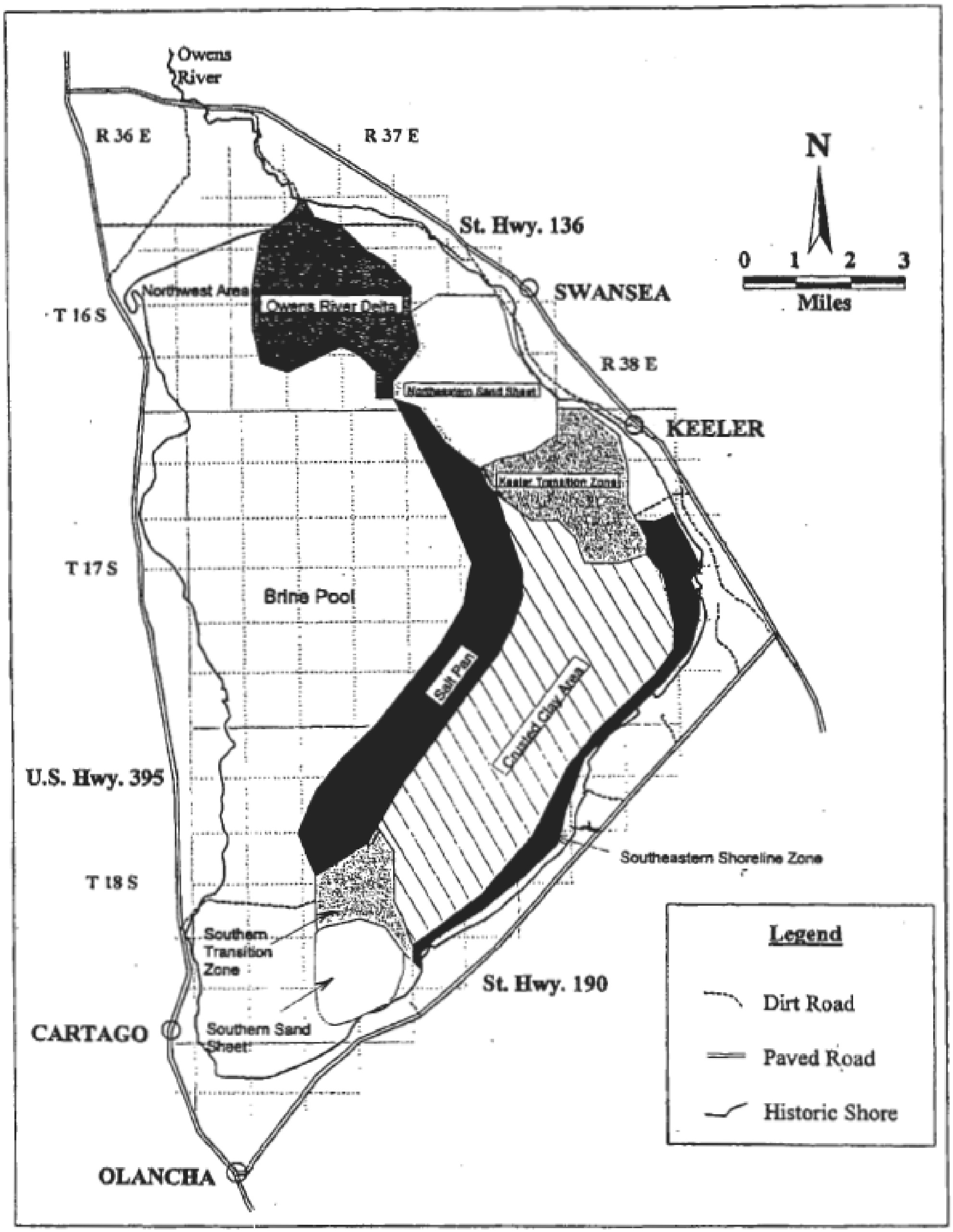

Figure 2. Locations of Brine Pool and Playa Environments on the Owens Lake Bed
(Source: GBUAPCD, 1997))

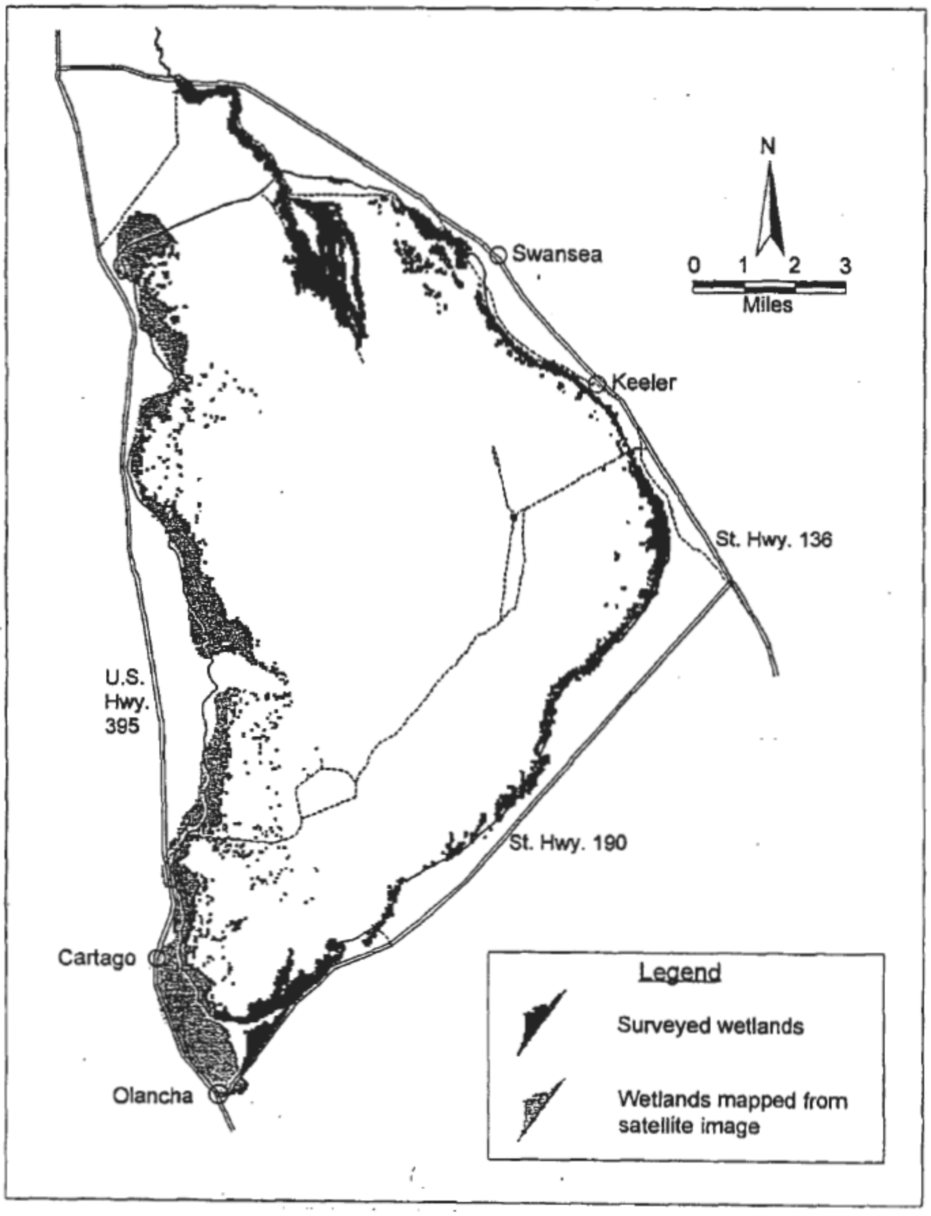

Figure 3. Jurisdictional Wetlands on the Owens Lake Bed (Source: GBUAPCD, 1997)

4. Background

A. Sources of Information and Data

The proposed amendments are based on Regional Board staff's review of relevant information and data on Owens Lake and its watershed in relation to state and federal water quality standards and criteria for the MUN use. Extensive field studies in the Owens Lake watershed, including water quality monitoring, wetlands mapping, and surveys of aquatic biota and wildlife, have been done on behalf of the Los Angeles Department of Water and Power (LADWP), the Great Basin Unified Air Pollution Control District (GBUAPCD), and the Inyo County Water Department. Many of these studies are summarized in Environmental Impact Reports (EIRs) for the Owens Valley PM_{10} Planning Area State Implementation Plan (GBUAPCD, 1997), the Lower Owens River Project (LADWP, 2004), and Inyo County's use permit for U.S. Borax mining and ore processing activities (Inyo County Planning Department, 2004).

Other sources of information and data include reports by the U.S. Geological Survey (USGS) and the California Department of Fish and Game's online Quad Viewer for the California Natural Diversity Database. The online USGS NWIS and USEPA STORET water quality databases were searched; however, they did not include data for surface waters of Owens Lake. Data provided by U.S. Borax in a 2002 NPDES permit application were also considered in development of the Basin Plan amendments. Additional information and data were provided by GBUAPCD and U.S. Borax staff. Water quality data are generally more abundant for ground water than for surface water at Owens Lake. This staff report does not include all of the available water quality data for Owens Lake, but summarizes representative data for different components of the hydrologic cycle.

B. The Owens Lake Environment

The following is an overview of environmental factors related to the water quality and beneficial uses of Owens Lake. Discussions of water quantity and quality are provided in Sections 5 and 6, below. Additional information on the environmental setting is included in the separate CEQA document (California Regional Water Quality Control Board, Lahontan Region, 2005).

Owens Lake is located in Inyo County, California, in a faulted basin between the Sierra Nevada and Inyo Mountains (Figure 1). It is bounded to the south by the Coso Mountains. The Owens Lake bed, within the historic shoreline at about 3600 feet elevation, has a total area of about 110 square miles. Modern Owens Lake is the natural terminus of the Owens River. During the Pleistocene, it was part of a chain of lakes extending from Mono Lake to Lake Manley in Death Valley (Tyler *et al.*, 1997). Prehistoric Owens Lake was about 330 feet deep and extended up to 20 miles north of its 19th century shoreline (Inyo County Planning Department, 2004; Johnson *et al*., 1999).

Natural evaporative processes beginning in the late Pleistocene led to a smaller and more saline lake. The last surface outflow from Owens Lake is estimated to have occurred 2,000 years ago (GBUAPCD, 1997). At the time of European settlement in the 19th century, Owens Lake was about 30 feet deep, and navigable by steamboats. Due to diversions, its surface waters are now mostly ephemeral. It has become a man-made desert playa, called Owens Dry Lake in some references. It shares some but not all of the characteristics of natural playa lakes in the Great Basin and Mojave deserts.

Before diversions from its tributaries began, Owens Lake was the third largest lake in California. Agricultural water diversions began in 1878. From 1872-1878, the lake surface level was 3,587 feet and it covered about 72,000 acres. In 1905, after a ten-year drought, the lake's area was 44,000 acres. Its area was 62,000 acres when diversions to the Los Angeles Aqueduct began in 1913. By 1924, Owens Lake had "essentially dried to its present conditions" (Inyo County Planning Department, 2004).

Most of the lakebed is owned by the State of California and controlled by the California State Lands Commission (LADWP owns part of the Owens River delta). The Commission leases portions of the lakebed to other public and private entities for mining, grazing, and rights-of-way. The largest leases belong to U.S. Borax and the GBUAPCD. The watershed surrounding Owens Lake includes U.S. Forest Service and U.S. Bureau of Land Management lands, and the small communities of Keeler, Cartago, Olancha, and Lone Pine. GBUAPCD (1997) estimated the total population of the unincorporated areas surrounding Owens Lake, including Lone Pine, at 3,230 based on 1990 census data. Land uses near Owens Lake include livestock grazing on pasture irrigated from springs and wetlands near the lake, and U.S. Borax's onshore salt processing facilities. The public has access on both LADWP and State Lands Commission properties for recreation including hunting, bird watching and fishing in the delta area (LADWP, 2004).

Geology and Soils. The Owens Lake basin is one of two structural basins within Owens Valley, the westernmost basin in the Basin and Range system. It extends from the south side of Tinemaha Reservoir near Big Pine to the south end of the Owens Lake playa. The valley sedimentary fill includes a mix of alluvial fan, fluvial, and lacustrine deposits over granitic and metamorphic bedrock. The deepest part of the Owens Lake structural basin is at the south end of the playa, where the sediment above bedrock extends to about 10,000 feet below the surface. The upper 1,000 -1,500 feet of sediments under the lakebed include thick sequences of lacustrine silty clay deposits with interstratified deposits of sands and sandy clays. Bishop tuff, from the eruption of the Long Valley Caldera in the upper Owens River watershed 758,000 years ago, is found at a depth of 997 feet below the surface. The Owens Lake bed is extremely flat, with only 58 feet of relief from the historic shoreline elevation of 3,600 feet to the lowest point on the historic lakebed at approximately 3,542 feet (GBUAPCD, 1997).

There are three major fault zones beneath the Owens Lake basin: the Owens Valley Fault Zone on the west of the playa, the Owens River Fault Zone that enters beneath the Owens River and extends southward along the east side of the brine pool, and the Eastern Block/Inyo Mountain Block Fault Zone beneath the northeast shore of playa. Faults can affect ground water movement. The potential exists for an earthquake of 8 or greater magnitude on the Richter scale. There is also a potential liquefaction hazard in areas of the playa with a high water table (Johnson *et al*., 1999; GBUAPCD, 1997).

Outside of the brine pool, the salt deposit on the playa surface is thin, and has been formed by the evaporation of saline ground water rather than from the dessication of the historic lake. This is the salt most prone to loss during dust storms. Deep drilling shows no evidence of evaporite salt deposits in lake sediment cores, and Owens Lake probably never dried to current levels before the diversion of its tributaries (GBUAPCD, 1997). Soil salinity outside of the brine pool, and the toxicity of certain elements such as sodium and boron to plants, are of concern in relation to the establishment of vegetation for dust control, and the maintenance of natural wetlands. Soil texture is variable on different parts of the lakebed, ranging from fine sand to clay. The GBUAPCD (1997) has identified eight different "environments" on the Owens Lake playa outside of the brine pool, differing in soil characteristics, depth to ground water, and salinity (Figure 2).

Climate and Air Quality. The mean precipitation in the Owens Lake watershed ranges from 4-17 inches per year depending on elevation and location (California Regional Water Quality Control Board, Lahontan Region, 2004). The Owens Lake area is in non-attainment status for state and federal air quality standards for particulate matter (PM_{10}), and windblown dust from the lakebed is the primary cause. Owens Lake is the largest single source of particulate air pollution in the United States. This situation is related to the lake's chemistry. The salt crust on the playa contains a higher proportion of sodium carbonate, sodium bicarbonate, and sodium sulfate salts than most other playas in California. Most other playas are strongly dominated by sodium chloride salt (halite). Halite does not undergo the dramatic volumetric phase changes that carbonate and sulfate salts do on Owens Lake. These changes break apart the playa surface and allow salts to be easily suspended by wind. Owens Lake is also one of the youngest dry lakes in the world, and its surface has not had time to stabilize naturally (Schade, 2002; GBUAPCD, 1997).

The City of Los Angeles and the GBUAPCD have entered in to an agreement to solve the Owens Lake dust problem by 2006, through a combination of three types of control measures. Shallow flooding spreads a thin sheet of water over dust-emitting areas of the playa. The "managed vegetation" measure, using drip irrigation, reclaims saline soils and establishes a protective cover of salt-tolerant salt grass *(Distichlis spicata*). The gravel blanket technique uses a 4-inch layer of gravel to armor the surface and prevent the capillary rise of salt crystals. All three approved dust control measures attempt to mimic natural processes. The total acreage of control measures needed to achieve 99% percent control of dust emissions is estimated at 25 to 35 square miles. Based on a cost of over $8 million per square mile for the first two phases, the entire project should cost $200-300 million when completed in 2006 (Schade, 2002). In 2002, the Lahontan Regional Board adopted WDRs (Board Order No. R6V-2002-0011) for LADWP's 19-square mile Southern Zones Dust Control Project. The project includes a water delivery and recycling system and storage ponds to supply irrigation water to the lakebed. The water comes from the Los Angeles Aqueduct and recycled return waters from irrigated areas.

Biological Resources. The Owens Lake brine pool and the eight "environments" on the playa surface vary in their quality as habitat for plants and animals, but all support biological resources to some extent. The consultants for the GBUAPCD (1997) EIR developed a list of more than 270 aquatic and terrestrial wildlife species that historically occurred, are known to occur presently or have the potential to occur at Owens Lake.

Owens Lake was saline/alkaline prior to diversions from its tributaries, and probably supported an aquatic ecosystem similar to those of other perennial inland saline lakes such as Mono Lake and Great Salt Lake. The Owens Lake brine pool is now so saline that brine shrimp and other aquatic invertebrates cannot survive in it, but it supports algae and bacteria adapted to high salinities. The salinity of other surface waters on the Owens Lake bed is variable but generally less than that of the brine pool (see Section 5, below), and the wetlands near the historic shore support diverse aquatic communities.

The Owens Lake brine pool below the Ordinary High Water Mark (see Figure 4) has been delineated as a jurisdictional "water of the United States" but not as a wetland (MHA Environmental Consulting, Inc., 1994). Figure 3 shows jurisdictional wetlands on the Owens Lake bed as of 1997. Additional mapping and delineation in the Owen River delta area were done in connection with the Lower Owens River Project (LADWP, 2004). Water sources for wetlands on the lakebed include springs, seeps, drilled artesian wells, and surface and subsurface flow from tributaries such as the Owens River. The amount of aquatic and wetland habitat on the Owens Lake is expected to increase with the implementation of dust control projects. Important wetland plant communities at Owens Lake include Alkali Seep, Great Basin Cottonwood-Willow Riparian Forest, and Transmontane Alkaline Meadow. The dominant wetland plant species is inland salt grass (*Distichlis spicata* var. *stricta*); this is the species being used in dust control. The main upland vegetation type in the immediate area of Owens Lake is shadscale scrub, dominated by Great Basin sagebrush (*Artemisia tridentata*), saltbush (*Atriplex* species), and greasewood (*Sarcobatus vermiculatus*) (GBUAPCD, 1997).

The unvegetated playa habitat at Owens Lake includes areas of open standing water and ephemeral pools that dry completely in summer. Perennial and ephemeral pools, from less than a quarter of an inch to several inches deep, provide wildlife habitat, including foraging habitat for numerous species of birds, primarily shorebirds. Some areas of the unvegetated playa contain dormant states of algae (diatoms and blue-green algae) in the dry crust. Brine and shore flies are among the most productive aquatic invertebrates in the habitats associated with the Owens River delta and the historic lake margins, and they are the preferred prey of water birds (GBUAPCD, 1997). Herbst and Blinn (1998) found at least 70 species of aquatic invertebrates in the springs, seeps and natural flood areas around the margins of Owens Lake. When dry, the unvegetated playa is not considered significant wildlife habitat, except for the snowy plover and American avocet nesting activities discussed below. Bats may forage over the dry playa, and terrestrial mammals use it for travel, but insects and other food resources are scarce (GBUAPCD, 1997).

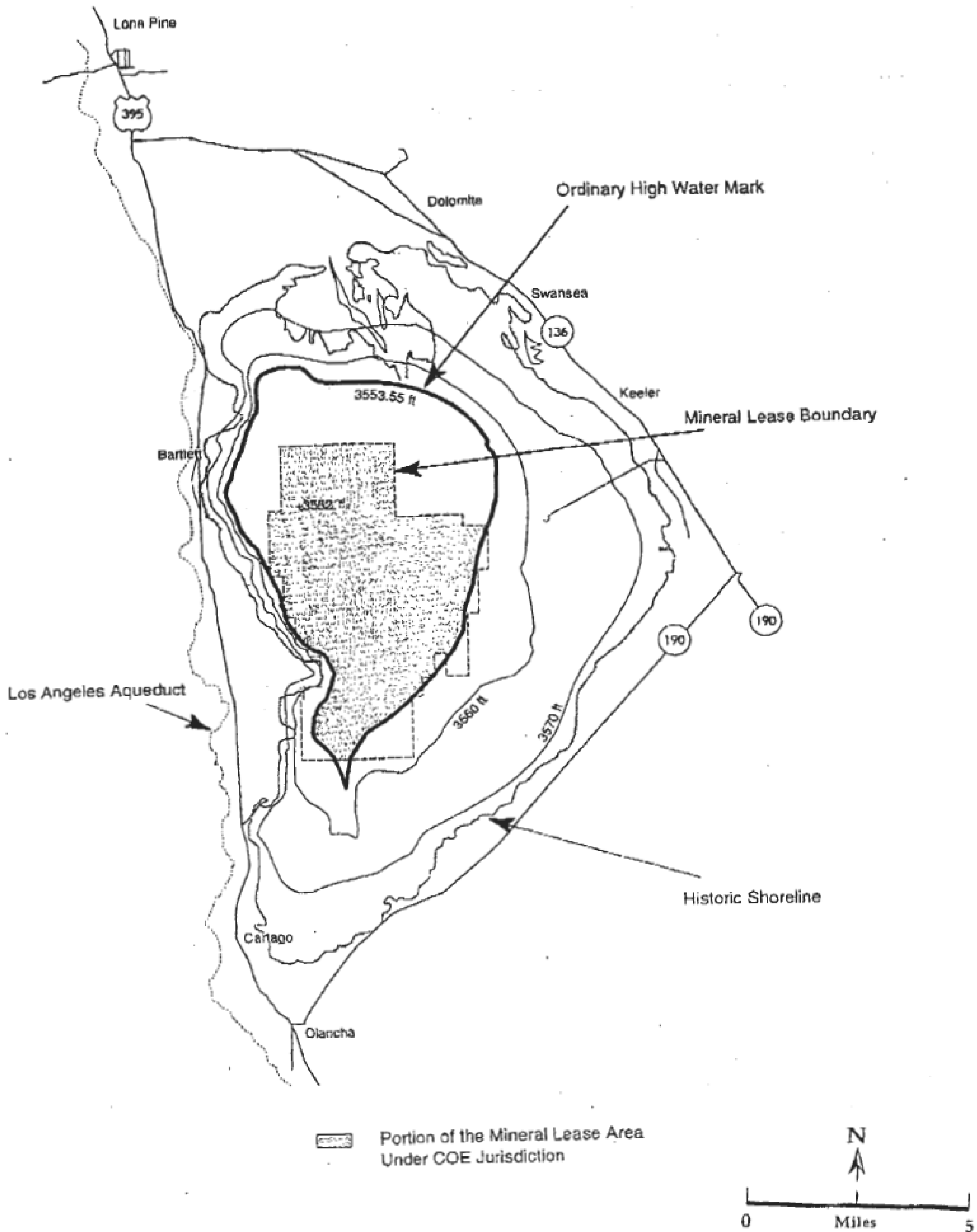

Figure 4. Ordinary High Water Mark of Owens Lake Brine Pool and U.S. Borax Mineral Lease Boundary. (Source: MHA Environmental Consulting, 1994, with modifications. The acronym "COE" in the legend stands for "U.S. Army Corps of Engineers.")

Sensitive Species and Habitats. The Owens Lake area supports at least 37 sensitive plant and animal species. A summary of information from the California Department of Fish and Game's California Natural Diversity Database is included in the environmental document for the Basin Plan amendments. In addition, wetland invertebrates include three species of tiger beetles that are unique to the Owens Lake area; they are restricted to damp habitats and prey on insects including brine and shore flies (GBUAPCD, 1997).

The U.S. Fish and Wildlife Service (Oring *et al.,* 2004) and Audubon California (Cooper, 2004) have recognized the importance of the wetlands and ephemeral waters of Owens Lake as habitat for breeding and migrating shorebirds and waterfowl. The Western Shorebird Plan (Oring *et al*., 2004) considers Owens Lake one of the key shorebird areas in the Intermountain West. Audubon California has designated Owens Lake as an Important Bird Area (IBA), part of an international network of sites targeted for conservation efforts. The criteria for the IBA designation include the presence of more than 10 percent of the state's interior breeding population of the western snowy plover; the presence of twelve sensitive bird species, and the possibility of seeing large numbers of shorebirds and/or waterfowl at one time.

The western snowy plover is a summer breeder and migrant at Owens Lake. Plovers nest in open, sparsely vegetated playas around the margins of the lake from March to July. Nests are located within 1,500 feet of freshwater areas such as seeps, ponds, and riparian corridors, where the birds can forage for brine flies and other aquatic invertebrates, drink fresh water, and thermoregulate (LADWP, 2004).

U.S. Borax Salt Mining and Processing. The following information is included in this staff report to place the proposed Basin Plan amendments in context. Additional information on U.S. Borax operations can be found in the Inyo County Planning Department's EIR (2004) and the Lahontan Regional Board WDRs.

Estimates of the amount of salt precipitated when Owens Lake dried range up to 300 million tons (Johnson *et al.,* 1999). The salt deposit (called "ore" by U.S. Borax) ranges from a few inches to nine feet deep, includes a mixture of trona, sodium sulfate and sodium chloride salts. Trona is an economically important hydrated double salt of sodium carbonate and sodium bicarbonate. Salt mining at Owens Lake began in 1887 with evaporation ponds near the lake shore, and there were several early 20th century mining operations on the lakebed following the dessication of the lake.

The Owens Lake operation now owned by U.S. Borax has mined salts using the "panel" method since 1976 (GBUAPCD, 1997). U.S. Borax has a mining lease on 16,120 acres of state land including much of the Owens Lake brine pool. The panel mining method involves isolating a block of ore from the lakebed with clay berms, and pumping interstitial brine for washing and processing. The use of mobile washing equipment on the Owens Lake bed was approved in 2004. Waste brine from the washing and dewatering process contains salts from the original brine, and industrial process chemicals including a flocculant. All of these wastes will be discharged to clay-lined tailing ponds. The current tailings ponds are mined-out panels above the Ordinary High

Water Mark of the brine pool. The U.S. Borax mining operation has an estimated 40-year lifetime, and a reclamation plan under the Surface Mining and Reclamation Act of 1975. The Regional Board's WDRs include additional provisions regarding closure. If the Basin Plan amendments are approved and the Regional Board approves a U.S. Borax discharge to the brine pool, similar closure provisions may be required.

5. Water Quantity and Quality

Water quality depends to a great extent on water quantity throughout the desert portions of the Lahontan Region, but this is especially true at Owens Lake. Although available information is summarized below in terms of compartments in the hydrologic cycle, it is important to recognize the potential for mixing of dissolved constituents between different components. Mixing can occur through flood or seismic events, wind driven water movements, infiltration of surface water into ground water, surfacing of ground water through springs and abandoned artesian wells, and "wicking" of ground water to the surface through evapotranspiration. The water quality data summarized in this section of the staff report are compared to state and federal standards and criteria for the MUN use in Section 6.

A. Units and Definitions

Water quantity is discussed below in units of acre-feet. One-acre foot (the volume of water that could cover one acre to a depth of one foot) equals 325,851 U.S. gallons. One acre-foot per year is equivalent to the amount of water that 2 or 3 households would consume in one year (California Coastal Commission, no date).

This report presents salinity data either as Total Dissolved Solids (TDS), or as Electrical Conductivity (EC). The latter parameter is also called Specific Conductance. The definitions of TDS and salinity depend on analytical methods, and TDS is usually used as an expression of the salinity of inland waters. Salinity is the sum of all dissolved ions; TDS is the mass of dissolved material estimated by evaporation to dryness at a specific temperature. A TDS concentration of 3,000 milligrams per liter (mg/L) is commonly used as a threshold between fresh and saline waters in the scientific literature (California Regional Water Quality Control Board, Lahontan Region, 2000). This threshold is also used in California's Sources of Drinking Water Policy. The USEPA uses a different TDS scale for its aquatic life criteria. Freshwater criteria generally apply to waters with TDS levels up to 1,000 mg/L, and saltwater criteria to waters with TDS over 10,000 mg/L. Between 1,000 and 10,000 mg/L, use of the more stringent set of criteria is recommended (USEPA, 2002, National Recommended Water Quality Criteria). TDS may not include bicarbonate and other ions driven off during the evaporation process. Since the Owens Lake brine pool includes large amounts of bicarbonate salts, its "salinity" (as the sum of all dissolved ions) is actually higher than indicated by TDS data.

EC is related to salinity in that saline solutions conduct electric currents. EC can be measured in the field, whereas TDS must be measured in the laboratory. The current units of EC are "Siemens" (it was formerly expressed in "mhos"). Commonly used EC units for ambient surface waters are deciSiemens per meter (dS/m), and milliSiemens or microSiemens per centimeter (mS/cm or µS/cm); these measurements are generally expressed in terms of a standard temperature such as 25^{o} C. One dS/m is equivalent to 1 mS/cm or 1000 µS/cm. Measurements of EC can be used to estimate TDS. The conversion factor used in the Regional Board's WDRs for U.S. Borax involves multiplying EC (in dS/m) by 640 to obtain TDS (in mg/L). The scientific literature reviewed in California Regional Water Quality Control Board, Lahontan Region (2000) recommends that EC should not be used to measure TDS if TDS exceeds 5 parts per thousand [5,000 mg/L]. California's Sources of Drinking Water Policy (see Section 6.B. below) uses 5,000 µS/cm as a threshold between fresh and saline waters.

In this staff report, constituents present in higher quantities (sodium, chloride, sulfate, etc.) are generally reported as milligrams per liter (mg/L), and trace elements as micrograms per liter (µg/L). One milligram equals 1,000 micrograms. Concentrations reported as parts per million have been converted to mg/L, and parts per billion have been converted to µg/L. For evaluation of the attainability of the MUN use, it is important to note that arsenic is usually considered a trace element, and drinking water standards for arsenic are expressed as µg/L. However, arsenic is present in Owens Lake brine in mg/L concentrations.

B. Hydrology

Studies of various components of Owens Lake's water budget have been done by the University of Nevada Desert Research Institute (DRI) since the 1980s, and the GBUAPCD sponsored modeling by DRI to project the availability of ground water for use in dust control projects. Johnson *et al.* (1999) and Camp, Dresser & McKee (1999) reviewed and critiqued the available data and the DRI models, and identified needs for further study.

Table 1 provides some idea of the relative sizes of different components of the present hydrologic cycle and the amount of water that could be available for municipal use if treatment were feasible. (See Section 6.C.4., below for a discussion of the feasibility of municipal use.) To put these amounts in perspective, about 320,000 acre-feet per year that would naturally reach Owens Lake are diverted to the Los Angeles Aqueduct, and the estimated water amount needed for dust control projects is about 64,000 acre-feet per year (Schade, 2002; LADWP, 2004). The amounts in Table 1 are estimates from different sources, and should not be added together with the purpose of obtaining a complete "water budget."

Table 1. Water inputs to and outputs from Owens Lake. (Sources: GBUAPCD, 1997; Johnson *et al*., 1999, LADWP, 2004 unless otherwise noted.)

Components	**Single figure estimate or annual mean amount (acre-feet)**	**Range (acre-feet per year)**
Inputs- Surface		
Direct precipitation (Inyo County Planning Dept., 2004)	75,000	
100 year flood event	175,000	
Owens River at Keeler Bridge (3 miles above playa)	15,789	1,916 to 221,372
Owens River, Delta Reach (1997)	5,820	3,840 to 7,800
Owens River, Delta Reach (predicted under LORP)		5,948 to 5,997
Tributary discharges over L.A. Aqueduct (estimated)		
Ash Creek	289	0 to 7,113
Braley Creek	37	0 to 1,254
Olancha Creek	1,754	
Cartago Creek	1,917	
Walker Creek	0	
Cottonwood Creek	1,967	0 to 45,440
Surface flows- springs, seeps, abandoned artesian wells	4,700	
Alluvial fan/interfluve infiltration	655	330 to 980
Inputs- Subsurface		
Total estimated recharge		5,000 to 20,000
Recharge to upper 1000 ft of sediments	3,875	
Mountain Block Recharge	15,850	4,000 to 10,000
Recharge from ephemeral stream channels, Inyo and Coso Mountains		1,100 to 2,000
"Down valley" ground water input from north of playa, upper 1000 feet	13,600	
Recharge from Centennial Flats area		7,400 to 15,600
Ground water Storage		
Total storage volume	59,994,400	
Available storage volume	13,995,800	
Outputs		
Ground water pumpage	5,173	
Evapotranspiration, vegetated areas of playa		6,300 to 12,000
Playa evaporation (including sand/clay dominated areas)	20,000	
Brine pool evaporation	21,300	
Total evaporation from lakebed	35,000	

C. Water Quality

Prediversion Owens Lake. As a terminal lake, Owens Lake has been considered a closed system. This is not completely true since there is some evidence of ground water outflow at the southern end of the lake, and since salts can be removed from the Owens Lake watershed through wind erosion from the dry lakebed (Smith and Bischoff, 1993 Johnson *et al*., 1999). USGS analyses of a deep sediment core show that closed lake conditions evidently occurred over 60 percent of the time during the past 500,000 years. The salinity of Owens Lake probably did not exceed 100,000 mg/L during any of the closed lake cycles. Only since the 1913 export of water has the saline playa developed (Johnson *et al*., 1999).

The alkaline properties of Owens Lake were described as early as 1875 in geological surveys conducted by the U.S. Army (GBUAPCD, 1997). Williams (2002) cites a 1920 USGS paper for TDS measurements in Owens Lake ranging from 16 to 214 grams per liter (16,000- 240,000 mg/L) between 1890 and 1914. A more recent USGS study (Smith and Bischoff, 1993) estimated the salinity of the lake in 1872, before diversions from its tributaries were made for agriculture, as 9 percent (90,000 mg/L), with an estimated pH of 10. Pre-1872 water chemistry was dominated by sodium, chloride, carbonate and sulfate. Hering (1997) theorizes that pre-diversion Owens Lake also had a high arsenic concentration, similar to that of Mono Lake. Monitored arsenic concentrations in Mono Lake have ranged from 4 to 28 mg/L (National Academy of Sciences, 1987).

Sources of salts and trace elements. The primary justification for removal of the MUN beneficial use designation from surface waters of Owens Lake is the presence of high concentrations of salts and/or toxic trace elements such as arsenic. These constituents are mostly from natural sources, although they have probably reached concentrations much higher than natural historic levels due to human diversions from tributaries to the lake.

Pretti and Stewart (2002) sampled Owens River tributary streams, and modeled weathering of rocks and ion inputs to Owens Lake over time. They concluded that up to 40 percent of the source water of prediversion Owens Lake originated near Minarets Summit, west of the Long Valley Caldera. They also concluded that Hot Creek (dominated by hydrothermal inputs) and Pine Creek (dominated by sulfide weathering from metasedimentary roof pendant rocks) were the most important sources of ion loading to Owens Lake. Of the modeled TDS loading, 39 percent came from Pine Creek and 35 percent from Hot Creek. The fumaroles and hot springs in Long Valley Caldera have TDS concentrations up to 1,330 mg/L, with 200-300 mg/L chloride. Pine Creek is a significant source of sulfate, and the highest carbonate load comes from Convict Creek, with watershed geology also dominated by a metasedimentary roof pendant.

Long Valley Caldera is a major source of arsenic loading to Owens Lake. Arsenic concentrations in Hot Creek range from about 120 to 330 μg/L, and concentrations in the hot springs in its watershed are even higher (740 μg/L in the Little Hot Creek springs). Regional Board staff's earlier literature review on saline and geothermal waters also showed that the hot springs in Long Valley Caldera are significant sources of other elements such as boron, fluoride and sulfate (LADWP data; California Regional Water Quality Control Board, Lahontan Region, 2000). Total arsenic is conserved in the Owens River system; the concentration reaching LADWP's treatment plants from the Los Angeles Aqueduct system is about 20 μg/L (Hering, 1997). There are some local sources of arsenic near Owens Lake. Mineralized upland areas caused high concentrations of arsenic in ground water near Keeler and led to abandonment of its original town well in the 1980s (Camp, Dresser & McKee, 1980).

There are some historic and current human sources of pollutant loading to Owens Lake, including lead smelters that operated between 1869 and 1876 (Smoot *et al.,* 2000); acid mine drainage from mining in the Pine Creek watershed (and probably other watersheds); discharges from past and present salt mining operations; copper sulfate used as an algicide in the Los Angeles Aqueduct system; pesticides and fertilizers used in dust control projects; and stormwater from developed and disturbed areas in the watershed. However, most of the salts and trace elements in surface and ground waters of the lake are probably from natural sources and have accumulated over geologic time.

Precipitation Inputs. As shown in Table 1, direct precipitation is a relatively large source of water for modern Owens Lake. There are no available data on precipitation quality for the Owens Lake area. Table 2, from a station on the west slope of the Sierra Nevada, gives some idea of the relative concentrations of salinity-related constituents in precipitation reaching Owens Lake. The concentrations in this table are volume-weighted mean values for wet-only precipitation between 1982 and 1995. They are low compared with those in the Owens River (Tables 3 and 4). Dry deposition was not measured at this site, and it may add to total loading to the lake. Precipitation at this station was characterized as "very dilute and slightly acidic."

Table 2. Precipitation quality data from Yosemite National Park (Source: Mast and Clow, 2000.) (Ion concentrations originally reported as microequivalents per liter were converted to milligrams per liter using standard conversion factors (Chapman and Pratt, 1961) and rounding.)

Parameter	**Number of Samples**	**Value in Precipitation**
Specific conductance (EC, field), mS/cm	207	4.5
pH (laboratory)	206	5.4
Calcium , mg/L	209	0.05
Magnesium, mg/L	208	0.02
Sodium, mg/L	211	0.09
Potassium, mg/L	210	0.01
Sulfate, mg/L	209	0.28
Chloride, mg/L	212	0.15

River and Stream Inputs. Tables 3 and 4 summarize long-term water quality data collected by LADWP and the USGS for the Owens River above the Owens Lake delta. Concentrations of TDS and individual constituents are low relative to concentrations in Owens Lake. As shown in Table 1, the Owens River provides the largest single source of stream input to Owens Lake. Long-term data on water chemistry of other streams directly tributary to Owens Lake are not available. Note the relatively high concentrations of arsenic (compared to the 10 μg/L federal drinking water standard) in both tables.

Table 3. Water Quality in the Owens River Below Tinemaha Reservoir (LADWP Data). (Data collected 1940-1991. All data are laboratory rather than field values.)

Parameter	**# of Samples**	**Mean**	**Minimum**	**Maximum**
Specific conductance (EC), uS/cm	521	316	153	747
pH	523	8.2	7.3	9.2
Alkalinity, mg/L	518	110	52	283
Hardness, mg/L	523	76	40	182
Sodium, mg/L	520	36	13	92
Sulfate, mg/L	520	24	7.3	84
Chloride, mg/L	523	15	3.2	46
Boron, mg/L	272	0.48	0.10	1.11
Fluoride, mg/L	522	0.59	0.27	1.10
Arsenic, μg/L	247	23	10	60

Table 4. Water Quality in the Owens River below Tinemaha Reservoir (USGS Data). (Data collected 1974-1986. All data are laboratory rather than field values.)

Parameter	**# of Samples**	**Mean**	**Minimum**	**Maximum**
Specific conductance (EC), μS/cm	103	287	158	422
pH	32	8.2	7.5	8.6
Total dissolved solids, mg/L	100	182	82	268
Alkalinity, mg/L	30	96	62	132
Hardness, mg/L	90	71	6	110
Sodium, mg/L	100	32	6	54
Sulfate, mg/L	99	23	5	46
Chloride, mg/L	101	13	4	35
Fluoride, mg/L	101	0.6	0.4	0.9
Aluminum, μg/L	15	18	10	30
Arsenic, μg/L	47	24	5	45
Cadmium, μg/L	47	2	0	15
Chromium, μg/L	47	2	0	10
Copper, μg/L	47	6	0	20
Selenium, μg/L	47	1	0	1

Stormwater Inputs. Conway (1997) sampled runoff events in ephemeral stream channels and on the alluvial fans of the Inyo and Coso Mountains between 1994 and 1996. Concentrations of bicarbonate, chloride, sulfate and potassium ions were generally higher in Coso Mountains runoff; Conway attributed this to the accumulation of windblown salts from the playa in the vicinity of the Coso Mountains monitoring site. Table 5 summarizes Conway's results for water quality parameters related to salinity; the figures are averages of 7 to 8 samples per station, collected in 1994 and 1995. The section on shallow flooded areas, below, provides information on surface runoff ponded on Owens Lake.

Table 5. Runoff Water Chemistry, Inyo and Coso Mountains. (Source: Conway, 1997.) (Units for EC were converted from μmhos/cm.)

Constituent	Average, Inyo Mountains	Average Centennial Flat	Average Coso Mountains 3 Sites	Average, Coso Southwest Upper Site
EC (μS/cm)	709	535	747	1195
pH	8.78	8.74	9.27	8.76
Chloride (mg/L)	64.0	25.3	43.5	j90.2
Sulfate (mg/L)	55.1	31.1	71	167
Bicarbonate (mg/L)	229	210	198	318
Sodium (mg/L)	152	115	159	256
Potassium (mg/L)	13.7	4.18	3.97	3.84
Calcium (mg/L)	4.97	5.43	2.78	5.47
Magnesium (mg/L)	1.21	1.19	1.24	0.63

Springs, Seeps, and Wetlands. Jurisdictional wetlands on the Owens Lake bed as of 1997 are shown in Figure 3, and the importance of wetlands as aquatic and wildlife habitat is discussed in Section 4.B., above. Wetlands are associated with streams (e.g., the Owens River delta) or with springs, seeps, or abandoned artesian wells. TDS levels in wetlands associated with Owens Lake range from 1,300 to 13,000 mg/L. Springs and seeps generally occur along the perimeter of the playa between 3,560 and 3,600 feet elevation (the historic lake shoreline), and "spring mounds " are associated with faulting in the northeast portion of the lake. Springs and seeps range in size from 15 to 770 acres, averaging 100 acres (GBUAPCD, 1997). Tables 6 and 7 summarize water quality data on a number of springs and wells on or near Owens Lake, from two different sources. There is considerable variation in water quality.

Springs in the Cartago/Cabin Bar Ranch area used for bottled water are located away from the lake margin and have TDS concentrations in the range of 110-200 ppm (GBUAPCD, 1997). Springs along the southeast margin of Owens Lake near the Coso Mountains have TDS concentrations of 5,000 to 7,000 mg/L, possibly due to salt water intrusion (Lopes, 1985).

Shallow Flooded Areas. Potential sources of flooding on the Owens Lake bed include local precipitation and runoff, accidental releases from the LADWP aqueduct system, and deliberate releases from the aqueduct due to high runoff conditions, routine maintenance, or dust control and rewatering projects on the lakebed. A 100-year flood event on Owens Lake could cover 175,000 acre-feet and flood about 28,000 acres to an elevation of 3,558 feet, about 4.5 feet above the Ordinary High Water Mark of the brine pool. An accidental release from the Los Angeles Aqueduct system (such as a "worst case" failure of the dam at Crowley Lake) would be similar to a 100-year storm (U.S. Borax, 2002; Inyo County Planning Department, 2004).

Table 6. Water Quality of Wells and Springs Near Northeast Spring Mounds on Owens Lake. (Source: Font, 1995.) (Except for pH, all units are mg/L, converted from milliequivalents per liter using standard conversion factors and rounding (Chapman and Pratt, 1961).)

	KTW	**KFW**	**KSI**	**L3**	**L4**	**Sulf**	**RWU**	**RWL**	**Mill**
Sodium	154.1	292.1	423.2	515.2	913.1	837.2	112.0	109.0	878.4
Potassium	22.9	12.4	48.0	57.3	3.5	25.2	26.6	15.4	76.1
Calcium	37.5	16.5	22.2	17.5	31.3	1.8	12.7	63.1	1.8
Magnesium	65.4	13.7	98.5	74.4	5.0	1.6	14.6	60.3	1.8
Chloride	95.0	102.1	250.0	300.0	468.1	264.2	27.4	89.0	274.1
Sulfate	107.6	115.3	3.0	<0.5	37.0	1.7	2.5	2.0	90.8
Bicarbonate	596.1	658.9	1,421.5	1,421.5	1,812.0	1,738.8	414.9	689.4	1,682.7
pH	7.96	7.98	8.06	7.49	8.45	8.34	8.37	7.4-7.9	8.23

Table 7. Water Quality of Springs Near Owens Lake Shoreline. (Source: Cochran *et al.*, 1988). (All values except pH are in parts per million (ppm) or mg/L.)

Sample No.	pH	Chloride	Sulfate	Sodium	TDS
3	7.49	300.00	<1.00	514.00	2460.4
4	8.45	467.00	3.70	39.70	343.64
8	9.16	210.00	345.00	458.00	1,536.89
9	6.85	1,180.00	536.00	1,340.00	4,947.70
11	9.58	2320.00	988.00	3,570.00	10,306.30
12	9.39	609.00	405.00	1,590.00	4,930.97
13	8.56	17.50	34.20	59.80	326.80
15	7.87	2.40	14.80	15.90	164.85
17	6.89	276.00	204.00	525.00	2249.8
18	7.80	494.00	252.00	880.00	3307.15
19	8.60	292.00	97.90	695.00	2418.39
20	9.80	276.00	54.10	628.00	2115.28
22	10.20	1,080.0	848.00	2080.00	6754.79
23	8.25	81.50	26.40	201.00	953.72
24	6.90	11.20	18.80	12.10	168.5
25	8.54	195.00	93.20	206.00	780.73

Font (1995) cites a flood event in 1969 "when the Owens River flow surpassed the capacity of the Los Angeles Aqueduct and the lakebed was flooded to a depth of 2.4 meters [about 7.8 feet]. During the summer of that year, the lake began to dessicate and was dry again by the summer of 1971." Concentrations of all the major ions except calcium and magnesium increased in lake water as the lake continued to dry. The deviations from increasing trends were attributed to precipitation of minerals containing calcium, sodium carbonate, sulfate and chloride.

Stormwater ponded on Owens Lake is likely to vary widely in water quality, and few recent samples are available. The GBUAPCD (1997) concluded that there are basically two water salinity regimes in the lakebed environment: brackish with TDS from 1,000 to 6,000 mg/L, and brines with TDS in excess of 40,000 mg/L. Outside of the brine pool, salts come mainly from evaporative concentration of shallow ground water. Using the assumption that total annual evaporation from the Owens Lake playa surface and open water is about 47 million cubic meters (about 38,000 acre-feet) of water, Tyler *et al.* (1997) estimated that up to 750,000 tons of salt per year are concentrated by evaporation at or near the playa surface.

Table 8 includes two samples of surface runoff on the lake. The "runoff pool" sample is much more saline than the "wetland runoff" sample and has higher concentrations of several specific constituents. Natural runoff pools on the Owens Lake playa dissolve surface salts and become more saline through evaporation.

As summarized in the Regional Board's 2002 WDRs for the Owens Lake Southern Zones Dust Control Project, the maximum depth of water in "Shallow Flooding" or "Habitat

Shallow Flooding" areas will be approximately 4 inches. The approximate TDS concentration of water used in these areas will be between 5,000 to 450,000 mg/L TDS. Most of the time the salinity level will be maintained in the upper portion of the range. The managed vegetation areas will have water depth "just enough for vegetative cover growth needs." The TDS concentration of water used for managed vegetation will vary between 5,000 and 126,000 mg/L. The operation ponds for the irrigation system will have average depths of about 3 feet and TDS will vary between 120,000 and 450,000 mg/L.

Table 8. Owens Lake Surface Water Quality Data, 2001. (Source: Unpublished Lahontan Regional Board/California Department of Fish and Game Study)

Approximate Location	TDS mg/L	Arsenic µg/g[1]	Selenium µg/g[1]	Chloride mg/L	Sulfate mg/L
Reporting Limit (RL)	**10**	**0.2**	**0.002**	**0.25**	**1**
Panel 28 Pump Station[2]	575,000	47.4	0.010	133,000	44,000
Runoff Pool	28,500	8.98	0.003	8,250	5,550
Brine Pool	430,000	40.4	0.008	91,600	26,300
Wetland Runoff	1,000	<RL	<RL	306	127
Sulfate well, Keeler	7,150	0.494	<RL	1,220	263

[1] Micrograms per gram
[2] This sample was mining waste brine.

Brine Pool. The brine pool is the area of Owens Lake below elevation 3,553.5 feet, the Ordinary High Water Mark established by the U.S. Army Corps of Engineers, and includes most of the area with mineable salt deposits (see Figure 4). There is typically surface water in the brine pool during at least part of the year depending on precipitation and runoff. The Ordinary High Water Mark corresponds to a surface area of about 20,000 acres. The area of the brine pool fluctuates seasonally and annually. It was at least 20,000 acres in 31 of 39 years between 1938 and 1987, and less than 5000 acres for 26 of those years (Inyo County Planning Department, 2004; MHA Environmental Consulting, 1994).

The brine pool consists of crystalline salt deposits and sediments covered by a thin layer of concentrated brine. Aerial photographs show that the main body of the brine pool along the west side of the lake is typically colored red and, may develop a crust of salt on the surface. The crust may break up into large rafts of salt during strong wind events. The red color is due to salt-tolerant algae and bacteria, the only aquatic organisms present in the brine. The salt content of the brine pool in the Owens River delta area is thought not to be as high as that of the main brine pool, and the color of the water is distinct (GBUAPCD, 1997). GBUAPCD cites the range of TDS concenetrations in Owens Lake brine as 250,000 to 470,000 parts per million (mg/L) depending on seasonally variable freshwater input. Tables 9 and 10 summarize data provided by U.S. Borax on salts and trace element concentrations in the brine pool. For comparison, the TDS concentration of "typical seawater" is 34,420 mg/L (California Coastal Commission, no date). Therefore, Owens Lake brine is about 12.5 times as salty as sea water. The highest salinity worldwide found in an earlier literature review by Regional Board staff was 474 g/L (or 474,000 mg/L) for Don Juan Pond in Antarctica (California Regional Water Quality Control Board, Lahontan Region, 2000). TDS levels in ambient Owens Lake brine approach this figure, and one measurement of waste brine at the U. S. Borax mining operation (575,000 mg/L, Table 8), exceeds it.

Table 9. Salinity-related data for Owens Lake Brine. (Source: U.S. Borax draft NPDES Permit Application report, January 2002.) (Data are from analyses by Innochem Engineering in 1994 and 1995. Report did not state sample numbers.)

Constituent	Value
Total Dissolved Solids (TDS)	430,000 mg/L
Hardness (as calcium and magnesium)	2 mg/L
Sodium	168,000 mg/L
Potassium	5,306 mg/L
Chloride	139,000 mg/L
pH	10.5

Table 10. Trace Elements in Owens Lake Brine. (Source: U.S. Borax draft NPDES Permit Application report, January 2002.) (Data are from analyses by Innochem Engineering in 1995. Sample numbers were not reported. Units of parts per million were converted to µg/L.)

Constituent	Average Brine Concentration (µg/L)
Aluminum	600
Antimony	200
Arsenic	110,000
Boron	278,000
Cadmium	1,000
Chromium (III)	1,300
Copper	500
Fluoride	31,000
Lead	100
Nickel	1,000
Vanadium	1,000

Ground Water. Ground water beneath Owens Lake is an important consideration because of the relatively large volume of ground water compared to other components of the hydrologic cycle (Table 1) and because of its roles as a source for springs, seeps, and wetlands, and a potential future supply for dust control projects. Because the small communities around Owens Lake obtain domestic water supplies from aquifers that may be connected with ground water beneath the lake, subsidence due to pumping and potential contamination of water supplies by lake brine are of concern.

There have been a number of studies of ground water recharge and hydrology in the Owens Lake watershed, and various models have been developed. Previous ground water studies were reviewed and critiqued by Johnson *et al*. (1999) and Camp, Dresser & McKee (1999). The reviewers identified limitations in the models and concluded that there are significant data gaps. Needs for further study included better characterization of aquifers and of communication between them, better quantification of different recharge sources, and study of the role of faults in ground water movement. There is also some evidence that the Owens Lake ground water basin is not closed. There may be some exchange of water (outflow and/or inflow) with the Rose Valley basin to the south. Surface brine influences the quality of shallow ground water, and there is a possibility of density-driven recharge from surface brine to deep aquifers. In September 1999, LADWP announced that it would not pursue ground water pumping for dust control in the short term, because Camp, Dresser & McKee had identified the need for additional studies to determine the amount of pumping that could take place without undesirable environmental impacts (Inyo County Water Department, no date).

The depth to ground water varies over the surface of the Owens Lake playa. It is at the surface in vegetated wetlands, from two to four feet below the surface in areas such as the Owens River delta, and from 10 to 16 feet below the surface in the "crusted clay area" (GBUAPCD, 1997). There is a shallow unconfined lakebed aquifer extending from the surface to at least 30 feet deep in some areas. Shallow ground water flows generally inward toward the brine pool (Johnson *et al*., 1999).

Ground water quality in the Owens Valley ground water basin as a whole (including ground water upstream of Owens Lake that provides municipal supply for most Owens Valley residents) is generally good, with TDS levels less than 300 mg/L. Water from public supply wells in the basin has an average TDS of 128 mg/L with a range of 60 to 587 mg/L (California Department of Water Resources, 2003).

Surface brine influences the quality of shallow ground water beneath Owens Lake. Discharge in the Owens River delta maintains a fresh water lens floating above saline ground water due to lower density, and mixing appears to be minimal (LADWP, 2004). Shallow observation wells indicate that brines extend to 20 to 30 feet in the eastern and southeastern portions of the lakebed. The TDS concentration in ground water is near 1,000 mg/L at the north and salinity increases southward, becoming 3,000 to 6,000 near the south end of the lake. The GBUAPCD (1997) concluded that the ground water beneath the Owens Lake bed was nonpotable, in part because of TDS levels above 1,000 mg/L. As discussed in Section 6, below, the current California drinking water standard for TDS is 500 mg/L, but the State Water Board considers all waters with TDS concentrations of 3000 mg/L or less to be potential sources of drinking water.

There have been several studies of toxic trace elements in the shallow ground water of Owens Lake. A U.S. Agricultural Research Service study (Vaughan, 2004) concluded that reduction of salinity, pH and boron in shallow ground water would be necessary for survival of vegetation planted for dust control. Tyler *et al*. (1997) reported boron concentrations in soil cores ranging from 180 to 1,300 mg/L. Levy *et al*. (1999) conducted leaching experiments showing that arsenic and fluoride "can be readily released from lakebed salts when exposed to natural precipitation." Table 11 summarizes data for shallow ground water reported by the GBUAPCD in connection with the Regional Board's WDRs for the Owens Lake Southern Zones Dust Control Project.

Deeper ground water is generally of better quality than shallow ground water influenced by brine. Table 12 summarizes data for selected constituents from several reports by Sierra GeoSciences (2002) on deep wells. They show ranges of concentrations in 5 to 6 samples per well collected about once a year between the 1990s and 2002. Most of these wells have TDS concentrations below the 3,000 mg/L Sources of Drinking Water Policy threshold and a relatively neutral pH compared to surface brine. Some of the deep well samples also included detectable uranium in relatively high quantities (see Table 13). Uranium is naturally present in granitic rocks of the Sierra Nevada, and has been detected in relatively high concentrations in some Sierra waters. Apparently, uranium and other radioactive constituents have not been monitored in surface waters of Owens Lake.

A USGS study of a deep sediment core in the Owens Lake bed (Smith and Bischoff, 1993), showed that salinity of deeper ground water varies with depth in a smooth pattern, with a minimum at 30 meters, gradually increasing to a maximum at about 150 meters and declining sharply thereafter to steady low values at 210 meters and below.

Table 11. Owens Lake Shallow Ground Water Quality (Source: GBUAPCD Sampling May-June 2001, cited in 2002 WDRs for Dust Control Project.)

Constituent	**Concentration Range**
Arsenic (μg/L)	11,325-164,331
Boron (μg/L)	189-2,230
Cadmium (μg/L)	3-47
Chromium (μg/L)	382-1,600
Copper (μg/L)	14-150
Lead (μg/L)	3-57
Magnesium (mg/L)	76-140
Nitrate (mg/L as N)	21-73
Potassium (mg/L)	631-7,640
Selenium (μg/L)	93-1,000
Sulfate (mg/L)	2,630-54,300
Vanadium (μg/L)	126-733
Electrical Conductivity (EC) dS/m	63-178
Total Dissolved Solids[1] (mg/L)	40,192-113,920
Total Alkalinity (mg/L as $CaCO_3$)	16,393-64,590

[1] TDS was calculated from EC as: TDS approximately equals. EC (dS/m) x 640.

Table 12. Data from Owens Lake Deep Wells. Source: November 2002 reports by Sierra GeoSciences LLC for GBUAPCD.
(Data reported as parts per billion are shown as µg/L)

Site	**Estimated TDS (mg/L) (Max/Min)[1]**	**Field pH (units) Max/Min**	**Sulfate (mg/L) Max/Min**	**Chloride (mg/L) Max/Min**	**Sodium (mg/L) Max/Min**	**Boron (mg/L) Max/Min**	**Arsenic (µg/L) Max/Min**
River Site, Upper Production Well	625-449	8.32-5.05	3 - <.5	60.1-26.6	175-109	3.56-2.51	<40- 4
River Site, Lower Production Well	812-747	8.04-6.50	2.78- <1	97.6-89.0	118-109	2.50-2.25	<40 --7
Fault Test Site, Todd #1	878-761	7.48-6.70	32.3-6.6	84.8-81.4	124-100	2.17-1.99	<40-7
Fault Test Site, Todd #2, Upper	1,872-1,684	9.00-8.77	14.1-1.9	320-304	681-598	14.4-9.0	< 40- <10
Fault Test Site, Todd #2, Lower	1,469-1,378	7.22-6.69	< 2.5- <1.0	232-196	316-288	6.23-5.23	< 40- <10
Keeler/Swansea Site, Upper Piezometer	1,580-1,482	7.86-7.46	<2.5 - <0.5	231-221	468-440	7.32-6.82	<40 - <2
Keeler/Swansea Site, Intermediate Piezometer	1,723-1,619	7.63- 7.25	<2.5 - <0.5	265-253	430-417	7.30-6.69	<40 -<2
Keeler/Swansea Site, Lower Piezometer	1,710-1,538[2]	7.44-7.02	<2.5 - <0.5	256-245	402-385	6.84-6.44	<40- <10
Mill Site, Upper Piezometer	2,379-2,145	8.68-8.54	144-126	274-253	897-830	15.3-13.9	476-367
Mill Site, Lower Piezometer	2,672-2,353	8.96-8.76	272-220	323-271	1,010-942	26.3-22.9	790-516
South Flood Irrigation Project Site	5,792-5.343	8.27-8.15	<2.5 - <0.5	1,300-1.240	2,360-2190	37.2-32.6	13.0- <2
Star Trek Site	2.074-1.872	7.69-7.91	49.6-32.7	155-132	736-661	9.58-8.99	<40 -<2
OL92-2 Site	12,155-11,830	8.81-8.70	2.5- <1.0	4,060-3,960	5,400-5,160	101-91.5	27-<10

[1] TDS was estimated from laboratory Specific Conductance (EC).
[2] Range does not include one anomalously high value

6. Use Attainability Analysis

The federal Water Quality Standards Regulation (40 CFR 131.3) defines a use attainability analysis as "... a structured scientific assessment of the factors affecting the attainment of a use which may include physical, chemical, biological and economic factors." Because no changes in other beneficial uses of Owens Lake are being proposed, this Use Attainability Analysis (UAA) focuses on the MUN use of surface waters. Federal guidance for removal of beneficial uses and federal water quality standards are referenced below. Because some, but not all, of the surface waters of Owens Lake have been formally delineated as waters of the United States, federal criteria for removal of beneficial uses may not be applicable over the entire lakebed. However, California's Sources of Drinking Water Policy uses some of the same criteria as the federal guidance, and is applicable to all surface and ground waters. For simplicity, the available surface water quality data are assessed in relation to both state and federal guidance.

A. Background for the MUN Use Designation

Until 1989, waters of the Lahontan Region were not designated for the MUN use unless they were actually being used for domestic supply. Most of the MUN use designations in the Regional Board's 1975 North and South Lahontan Basin Plans were for ground water basins. In 1988, the State Water Board adopted Resolution 88-63, the Sources of Drinking Water Policy. This policy includes criteria for identification of water bodies as drinking water sources to be protected under Proposition 65, the Safe Drinking Water and Toxic Enforcement Act of 1986, California Health and Safety Code Section 25249.5 *et. seq.* Proposition 65 prohibits discharges of any chemical "known to the State to cause cancer or reproductive toxicity" to a potential source of drinking water, with certain exceptions. The State Water Board directed the Regional Water Boards to identify "sources of drinking water" within their regions using the criteria in the policy, and to amend their Basin Plans to designate MUN uses for these sources.

In 1989, the Lahontan Regional Board amended its 1975 Basin Plans to designate MUN uses for almost all surface and ground waters in the Lahontan Region, including inland saline lakes and geothermal springs. The rationale for this action was that, due to the scarcity of water supplies much of the region, it might be feasible and desirable to treat and use even poor quality waters in the future. The Board also lacked the staff resources and water quality data necessary to assess all water bodies in the Lahontan Region on a case-by-case basis for their suitability as drinking water sources. A university study of the beneficial uses of wetlands in the early 1990s (Curry, 1993) included field verification of aquatic and wildlife habitat uses of wetlands near Owens Lake but did not address their suitability for the MUN use.

The North and South Lahontan Basin Plans were replaced by a single Lahontan Basin Plan in 1995. Tables 2-1 and 2-2 in the current plan do not distinguish between existing and potential beneficial uses. The Lahontan Basin Plan (pages 2-3 to 2-4) recognizes that some beneficial uses of surface water may occur only temporarily, but does not specifically designate seasonal uses. Water quality standards and antidegradation regulations are meant to protect both existing and potential uses, and uses that occur only seasonally. The determination whether a use is existing or potential must be made on a case-by-case basis.

B. Guidance for Removal of a Beneficial Use

Federal regulation and guidance. Federal guidance for designation or removal of beneficial uses is contained in the Water Quality Standards Regulation (40 CFR 131.10) and the *Water Quality Standards Handbook* (USEPA, 1994). The Water Quality Standards Regulation defines "existing uses" as "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." States may remove existing beneficial uses only under very limited circumstances, e.g., when a use requiring more stringent water quality criteria is added. At a minimum, uses are considered attainable if they can be achieved by the imposition of effluent limits required under Sections 301(b) and 306 of the federal Clean Water Act and cost effective and reasonable best management practices for nonpoint source control. The Water Quality Standards Regulation allows states to remove designated beneficial uses that are not existing uses. The following is a non-verbatim summary of the provisions of the regulation, from Section 40 CFR 131.10(g), that are most applicable to removal of the MUN use from surface waters of Owens Lake.

States may remove a designated use that is not an existing use if the state can demonstrate that attaining the designated use is not feasible because:

- Naturally occurring pollutant concentrations prevent the use

- Natural, ephemeral, intermittent or low flow conditions or water levels prevent the use

- Human-caused conditions or sources of pollution prevent the use and cannot be remedied

- Dams, diversions or other types of hydrologic modifications preclude attainment of the use, and it is not feasible to restore the water body to its original condition or to operate the modification(s) in a way that would result in attainment of the use

- Controls would require in substantial and widespread economic and social impacts.

State Water Board Sources of Drinking Water Policy (Resolution 88-63). This policy states that surface and ground waters of the State are to be considered suitable, or potentially suitable, for municipal or domestic water supply and should be so designated by the Regional Boards with the exception of surface and ground waters where:

“a) The total dissolved solids (TDS) exceed 3,000 mg/l (5,000 uS/cm, electrical conductivity) and it is not reasonably expected by Regional Boards to supply a public water system, or

b) There is contamination, either by natural processes or by human activity (unrelated to a specific pollution incident), that cannot reasonably be treated for domestic use using either Best Management Practices or best economically achievable treatment practices.”

The provisions above are the parts of the policy most applicable to removal of the MUN use from surface waters of Owens Lake. A copy of the full policy is included as an appendix to the existing Lahontan Basin Plan.

C. Owens Lake Meets Criteria for Removal of the MUN Use

1. <u>MUN is not a historical or existing use of surface waters of Owens Lake.</u>

A natural history guide to the Owens Valley, Putman and Smith (1995), includes the following statement about Owens Lake in the 19th century:

> *“Old-timers tell that the salty water had marvelous cleansing properties, though if one left his clothes soaking too long there might be nothing left. Others claimed drinking it cured various ailments. In 1882 some San Francisco promoters planned to ship a carload of the water and began buying all the empty barrels they could find.”*

No further information about this commercial venture, or historical medicinal use of Owens Lake water by local residents, is available. A literature review on saline lakes (California Regional Water Quality Control Board, Lahontan Region, 2000) shows that the waters of other hypersaline lakes have been used for medicinal purposes. Occasional medicinal use should not be equated with lifetime drinking water supply. Federal drinking water standards and criteria are based on assumptions about the health risks of pollutants ingested by a person weighing 70 kilograms (about 154 pounds) drinking two liters (approximately one half gallon) of water per day over a lifetime (USEPA, 2000). There are no records indicating historic use of any of the surface waters of Owens Lake as a long-term drinking water source, or showing that these waters have been used for domestic supply since the November 28, 1975 threshold date for existing uses in the federal Water Quality Standards Regulation.

MUN is an existing use of the ground water of the Owens Valley basin as a whole, and of ground water from wells above the historic shoreline of Owens Lake. The communities of Keeler, Olancha and Cartago use domestic wells to supply most of their drinking water needs. These wells are located above the historical Owens Lake shore. The TDS concentration in water from the Keeler Community Services District well is approximately 830 mg/L, and is the freshest water measured on the east side of the Owens Lake basin. Ground water from wells located above the lake shore is also pumped for export to commercial users such as such as Anheuser-Busch at Cabin Bar Ranch and Crystal Geyser (GBUAPCD, 1997).

As noted in Section 5, ground water hydrology beneath the Owens Lake bed is complex and needs further study. The impacts of pumping ground water from beneath the lakebed on domestic water supplies from wells above the historic shoreline are of concern to stakeholders. For these reasons, the Regional Board is not proposing removal of the MUN use from ground water beneath the lake, and protection of the MUN use of ground water is an ongoing consideration in Regional Board permitting and enforcement activities.

2. Considerations related to pollutants justify removal of the MUN use.

Review of available information and data shows that the surface waters of Owens Lake are in violation of standards and criteria for the MUN use for a number of pollutants. These pollutants are from natural sources and have been concentrated through evaporation due to the diversion of Owens Lake's tributaries. Owens Lake was highly saline, and probably had high concentrations of pollutants such as arsenic, prior to the diversions.

Section 5, above, shows that the surface waters of Owens Lake vary in quality and quantity. Although data are limited, water quality probably varies seasonally and annually in most surface waters away from spring and well sources. The tables above show that some wetlands and springs have TDS levels lower than the 3,000 mg/L threshold in the Sources of Drinking Water Policy. However, other factors discussed below make it unlikely that these limited sources will every be developed for municipal supply.

a. Applicable Standards and Criteria

The following discussion provides background information on state and federal water quality standards, and on selected water quality criteria applicable to Owens Lake.

Beneficial Uses. If the MUN use is removed from the surface waters of Owens Lake, the remaining beneficial uses of surface and ground waters will still be used to interpret compliance with applicable state water quality objectives and federal standards, and in setting effluent limitations in Regional Board permits. In addition to MUN, the designated beneficial uses of Owens Lake are Water Contact Recreation (REC-1), Non-contact Water Recreation (REC-2), Cold Freshwater Habitat (COLD), Warm Freshwater Habitat (WARM), Inland Saline Water Habitat (SAL), and Wildlife Habitat (WILD). Wetlands on the Owens Lake bed have additional designated uses of Water Quality Enhancement (WQE) and Floodwater Retention (FLD). Due to variations in surface water quantity and quality over its area of 110 square miles, most of these uses may not occur at all times in all parts of Owens Lake. However, all of these uses are probably existing uses for some of the surface waters of Owens Lake at some seasons of the year. Other surface water uses may occur that are not currently listed in the Basin Plan , e.g., Rare, Threatened or Endangered Species (RARE). Existing uses must be protected whether or not they are formally designated. In addition to MUN, the designated beneficial uses of ground water of the Owens Valley ground water basin as a whole include Agricultural Supply (AGR), Industrial Service Supply (IND), (Freshwater Replenishment (FRESH) and Wildlife Habitat (WILD). (See the entry for Basin 6-12 in Table 2-2 in the Basin Plan.)

Water Quality Objectives. California's water quality objectives are defined in Water Code Section 13050(h) as "limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area." (The term "water quality objectives" will be abbreviated as "objectives" for the remainder of this staff report.) Objectives are regulatory and enforceable, in contrast to state and federal criteria. When applied to ambient surface waters, criteria are non-enforceable guidance levels unless they are adopted or promulgated as state standards.

The Lahontan Basin Plan includes some objectives that apply regionwide, and others that apply specifically to certain water bodies or watersheds. Owens Lake does not have site-specific narrative or numerical objectives, although numerical objectives for certain constituents apply to some of its tributary streams. The regionwide narrative objectives for Chemical Constituents, Pesticides and Radioactivity in surface waters reference state Maximum Contaminant Levels (drinking water standards). These standards would not apply to surface waters of Owens Lake if the MUN use were removed. Similar narrative objectives for ground water beneath Owens Lake would remain in effect, and would be a consideration in evaluating discharges with the potential to affect ground water quality.

There are a number of narrative objectives for all surface waters of the Lahontan Region that specify that waters shall not contain certain pollutants in concentrations "that adversely affect beneficial uses" or that water not be altered to the extent that there are adverse effects on beneficial uses. Removal of the MUN use would alter the context for interpreting the application of these objectives to Owens Lake.

Maximum Contaminant Levels (MCLs). (The following information is taken largely from the Central Valley Regional Water Quality Control Board's *Water Quality Goals* database.) California's state MCLs are adopted by the California Department of Health Services (DOHS) under CCR Title 22 Division 4, Chapter 15. California MCLs apply to treated drinking water and (under the narrative objectives for Chemical Constituents, Pesticides, and Radioactivity in the Lahontan Basin Plan) to ambient surface waters designated for or the MUN use. If they are fully protective of human health, MCLs may also be used to interpret narrative objectives prohibiting toxicity to humans in waters designated for the MUN use. The USEPA also adopts MCLs under the Safe Drinking Water Act. For ambient surface waters, federal MCLs are criteria, not enforceable standards. If a federal MCL is more stringent than a California MCL, DOHS is required by law to revise the state MCL to be at least as stringent as the USEPA criterion. (For example, DOHS is now in the process of revising the state MCL for arsenic to be at least as stringent as the USEPA MCL.)

Primary MCLs are derived from scientific health-based criteria, but they also include technologic and economic considerations based on the feasibility of achieving and monitoring these concentrations. Secondary MCLs are based on human welfare considerations (e.g., taste, odor, and laundry staining). This distinction applies to both the state and federal MCLs.

Antidegradation. In addition to beneficial uses and objectives, California's water quality standards include State Water Board Resolution 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California," also known as the "Nondegradation Policy." The U.S. Environmental Protection Agency, Region IX, has also issued detailed guidelines for implementation of federal antidegradation regulations for surface waters (40 CFR 131.12). State and federal antidegradation regulations allow lowering of existing water quality under certain circumstances, but require protection of all existing beneficial uses.

California Toxics Rule (CTR) Standards. The USEPA has promulgated numerical water quality standards for inland surface waters in California for a number of toxic organic and inorganic chemicals (Federal Register Vol. 6, No. 97, pp. 31682-31719, 18 May 2000, and Vol. 66. No. 30, pp. 9960-9962, Tuesday 12 February 2001). The CTR reiterates several criteria that the USEPA promulgated in 1992 for California and other statutes under the National Toxics Rule. CTR standards address protection of both human health and aquatic life. For waters designated for the MUN use, the human health standards consider exposure from consumption of both water and fish that had lived in the water. For waters not designated for the MUN use, the human health standards consider contaminated fish consumption only. The organic compounds covered in the CTR are industrial chemicals or pesticides that are not likely to be present at levels of concern in Owens Lake, considering the land uses in its watershed. The CTR standards for the metals detected in surface waters of Owens Lake are based on consumption of both drinking water and fish or aquatic organisms. It is difficult to assess compliance with these standards since no tissue data for fish or other aquatic organisms are available for Owens Lake. Some introduced warmwater fish are present in wetlands near the Owens River delta; the extent to which these fish are caught and consumed by humans is unknown. No other aquatic organisms at Owens Lake are currently consumed, although Native Americans may have eaten brine flies from the pre-diversion lake as they did historically at Mono Lake. Because of the lack of data, compliance with the CTR standards will not be assessed further in this staff report. As shown in Table 13, for both of the constituents with a CTR standard, other more stringent standards apply. The CTR standards for protection of human health will continue to apply to surface waters of Owens Lake even if the MUN use is removed due to the potential for recreational access to portions of the lakebed.

California State Action Levels are criteria published by the DOHS for chemicals with no drinking water MCLs. They are based mostly on health effects but may be set at higher concentrations than health-based values due to the limitations of readily available analytical methods. Action Levels are risk-based advisories to water suppliers, not surface water standards.

Proposition 65 Maximum Allowable Dose Levels. Proposition 65 makes it illegal to discharge significant amounts of known human carcinogens or reproductive toxicants to sources of drinking water. These "significant amounts" are the safe harbor levels established by DOHS in Title 22 of the California Code of Regulations, Division 2, Chapter 3. They include several different criteria. For reproductive toxicants, Maximum Allowable Dose Levels are set at 1/1000 of the "no observable effect level."

USEPA Drinking Water Equivalent Level (DWEL) for Sodium. The USEPA has issued a non-regulatory drinking water criterion of 20 mg/L for sodium for persons who must restrict sodium intake from all sources (including food) to prevent hypertension (high blood pressure). The USEPA (2003) recently reviewed scientific literature on health effects of sodium but decided not to develop a new (regulatory) human health standard for it under the Safe Drinking Water Act.

b. Compliance with Standards and Criteria

Drinking Water Standards. Table 13 assesses compliance with state and federal drinking water standards and criteria for 18 constituents that have been monitored at Owens Lake. Water in the brine pool exceeds at least one of the standards or criteria described above for 14 of these constituents. Some constituents such as selenium and uranium were not analyzed in the brine pool but may also be present there. Most of the studies of surface waters other than the brine pool monitored TDS and/or major constituents of TDS such as sodium, chloride and sulfate. Analyses of trace elements are generally not available for these waters.

Most of the springs in Table 7 have TDS levels below the 3,000 mg/L threshold in the Sources of Drinking Water Policy, but above the 500 mg/L California secondary MCL. Almost all wells and springs have sodium concentrations exceeding the 20 mg/L USEPA criterion, and there are a number of violations of the secondary MCLs for chloride and sulfate. Metals and trace elements such as arsenic and boron were not analyzed in these wells and springs.

The salinity data in the Regional Board's WDRs for the Owens Lake Southern Zones Dust Control Project indicate that all surface waters in this area are expected to exceed drinking water standards and criteria, even though the project will be irrigated with relatively good quality water from the Los Angeles Aqueduct. Data for shallow ground water constituents are included in Table 13 because this ground water can influence the quality of ephemeral surface water and shallow-flooded dust control areas on the Owens Lake playa. Shallow ground water constituents exceed standards or criteria for 10 of the constituents in Table 13.

Other components of the MUN Use. As noted in Section 2, the MUN use may include human uses of water for purposes other than drinking. In terms of water quantity, one of the most important of these uses is landscape watering. High salinity is detrimental to plants both because it makes it more difficult for roots to obtain water from soil, and

Table 13. Compliance With Drinking Water Standards and Criteria. (Source of Criteria: California Regional Water Quality Control Board, Central Valley Region Water Quality Goals Database. Units are µg/L unless otherwise noted.)

Constituent	CA Primary MCL	CA Secondary MCL	CA Toxics Rule Human Health Standard[1]	Other Criteria	Owens Lake Values
Aluminum	1,000	200		USEPA Secondary MCL= range of 50 to 200	600 (brine pool)
Antimony	6		14	USEPA Primary MCL = 6	200 (brine pool)
Arsenic	50[2]			USEPA Primary MCL =10 Proposition 65 Maximum Allowable Dose =0.05	110,000 (brine pool) 11,325 -164,311 (ground water)[6]
Boron				CA State Action Level = 1,000	278,000 (brine pool) 189-2,230 (ground water)
Cadmium	5			USEPA Primary MCL =5 Proposition 65 Maximum Allowable Dose= 2.05	1,000 (brine pool) 3-47 (ground water)
Chromium, Total	50				1,300 (brine pool, Cr III) 382-1,600 (ground water)
Chloride (mg/L)		250		USEPA Secondary MCL= 250	91,600-139,000 (brine pool) 2.4-2,320 (springs) 306 (wetland runoff)
Fluoride	2,000			USEPA Primary MCL =4,000; USEPA Secondary MCL = 2,000	31,000 (brine pool)
Nickel	100		610		1,000 (brine pool)
Nitrate (mg/L)	45 [3]			USEPA Primary MCL =10	21-73 mg/L (shallow ground water)
pH (units)[4]				USEPA Secondary MCL =6.5-8.5	10.5 (brine pool), 6.85-10.20 (springs)
Selenium	50			USEPA Primary MCL = 50	93-1,000 (ground water)

Constituent	**CA Primary MCL**	**CA Secondary MCL**	**CA Toxics Rule Human Health Standard[1]**	**Other Criteria**	**Owens Lake Values**
Sodium (mg/L)				USEPA Drinking Water Equivalent Level 20	168,000 (brine pool) 12.10-357 (springs)
Specific Conductance, µS/cm[5]		900			63,000-178,000 (ground water)
Sulfate (mg/L)		250		USEPA Primary MCL- 500; USEPA Secondary MCL = 250	26,300 (brine pool); 127 (wetland runoff); 2,630-54,300 (shallow ground water)
Total Dissolved Solids (mg/L)		500		USEPA Secondary MCL =500	430,000 (brine pool) 168.5-10,306.3 (springs) 1,000 (wetland runoff) 40,192-113,920 (shallow ground water)
Uranium (picocuries/L)	20 pCi/L			USEPA Primary MCL=30	Ground water 0.2 to 23.5 pCi/L
Vanadium				CA State Action Level 50	1,000 (brine pool) 126-733 (ground water)

[1] CTR human health standards are expressed in terms of water and fish consumption.
[2] The California Department of Health Services plans to revise the state arsenic MCL to be consistent with the federal MCL by 2006.
[3] The California MCL for nitrate is 45 mg/L “as nitrate.” This is equivalent to the federal MCL=10 mg/L “as N.”
[4] The Lahontan Basin Plan includes a narrative objective for pH with the same range of pH units as the State MCL.
[5] The California MCL for Specific Conductance is expressed as µmho/cm
[6] Except for uranium, all references to ground water in this column are for shallow ground water (see Tables 12 and 13).

and because of the adverse effects of specific constituents such as sodium, chloride, and boron. Although some of the springs associated with Owens Lake might be suitable for the home landscape watering component of the MUN use, most surface waters of the lake, including the brine pool, are not suitable. The United Nations Food and Agriculture Organization (FAO) has issued criteria for salinity and specific chemical consituents in irrigation water for crop plants (Table 14), and the more saline surface waters of Owens Lake exceed many of those criteria. The FAO agricultural criterion for TDS is 450 mg/L, about 1/1000 of the salinity of the Owens Lake brine pool.

3. Conditions related to water quantity and diversions justify removal of the MUN use.

The ephemeral nature of surface water on Owens Lake due to diversions from its tributaries, and seasonal and annual variations in the quality of most remaining surface waters, are major factors in its unsuitability for municipal use. If treatment of surface water to drinking water quality should become feasible, the overall quantity available would still vary significantly, and the lake could not be considered a reliable source.

4. Municipal use of the surface waters of Owens Lake is not technically or economically feasible.

Permit conditions. The federal regulation provides that beneficial uses cannot be removed if they can be attained by implementing effluent limits for point sources or cost effective and reasonable Best Management Practices for nonpoint sources. Water quality standards and criteria associated with the MUN use cannot feasibly be attained in the surface waters that violate them, since the violations are not due to point or nonpoint source discharges but to naturally high levels of consitutents aggravated by the effects of diversions. Mitigation for the impacts of permitted point source discharges to Owens Lake has already been applied by Inyo County, the Lahontan Regional Board, and other responsible agencies under CEQA. The Regional Board's WDRs do not require removal of natural constituents from the brine. It would be economically (and probably technically) infeasible for dischargers to remove natural constituents to levels suitable for the MUN use (see the discussion of desalination below).

Socioeconomic considerations. The federal Water Quality Standards Regulation provides that beneficial uses that are not existing uses can be removed if controls would result in substantial and widespread economic and social impacts. The Los Angeles Aqueduct system has 8 reservoirs with combined a combined storage capacity of about 323,000 acre feet. Water from the system passes through 12 power plants and generates more than 1 billion kilowatt hours per year, enough to supply the needs of 222,000 homes (California Department of Water Resources, 2005). Ending diversions would require Los Angeles to find both an alternate municipal water source and an alternative power supply. These substantial socioeconomic impacts would occur in addition to the impacts of existing dust control operations. LADWP has already committed about 16 percent of the

Table 14. Owens Lake Constituents Exceeding United Nations Food and Agriculture Organization Agricultural Water Quality Goals. Goals are from the Central Valley Regional Water Quality Control Board Water Quality Goals database. Units are µg/L unless otherwise noted.

Constituent	Agricultural Water Quality Goals	Owens Lake Values
Arsenic	100	110,000 (brine pool) 11,325 to 164,311 (ground water)
Boron	700	278,000 (brine pool) 189-2,230 (ground water)
Cadmium	10	1,000 (brine pool) 3-47 (ground water)
Chloride (mg/L)	106	91,600-139,000 2.4-2320 (springs) 306 (wetland runoff)
Copper	200	500 (brine pool) 14-150 (shallow ground water)
Fluoride	1,000	31,000 (brine pool)
Nickel	200	1,000 (brine pool)
pH	6.5-8.4	10.5 (brine pool) 6.85-10.20 (springs) 6.5-9.0 (ground water)
Selenium	20	93-1,000 (ground water)
Sodium (mg/L)	69	168,000 (brine pool) 12.10-357 (springs)
Specific Conductance (EC) µmho/cm[1]	700	63,000-178,000 (shallow ground water)
Total Dissolved Solids (mg/L)	450	430,000 (brine pool) 168.5-10306.3 (springs) 1,000 (wetland runoff) 40,192-113,920 (shallow ground water)
Vanadium	100	1,000 (brine pool) 126-733 (ground water)

[1]The EC units µmho/cm and µS/cm are equivalent.

Los Angeles Aqueduct water supply (51,000 acre-feet per year) at a cost of about $16.5 million (Schade, 2002). The most recent estimate of total water requirements for dust control is 64,700 acre-feet per year (LADWP, 2004). Ending diversions of tributary waters to the Los Angeles Aqueduct system might, over time, allow Owens Lake to return to its 19th century volume and water quality conditions, but it would still be an alkaline lake exceeding the Sources of Drinking Water Policy threshold for TDS, and probably exceeding MCLs for chloride, sulfate, and other constituents.

The saline surface waters of present-day Owens Lake could not be used for municipal supply without treatment. Any treatment process would need to address both overall desalination and removal of specific constituents such as arsenic. Local domestic water needs are met by ground water from sources much less saline than Owens Lake. The resident population of the area surrounding Owens Lake is small, and treatment of the surface waters of Owens Lake for additional municipal supplies would probably be a significant economic burden. A single regional water treatment plant would probably be more feasible than multiple small plants, and additional costs would be associated with construction and maintenance of new distribution systems to supply a relatively large area.

The latest (2005) draft of the California Department of Water Resources' *California Water Plan* includes information on costs and other considerations for desalination. The estimated capital cost of a desalination plant treating 187,000 acre-feet per year is about $1 billion. Water cost estimates based on an estimated 20-30 year lifetime for the plant are: groundwater or brackish water, $250-$500 per acre-foot; wastewater, $500-$2,000 per acre-foot; seawater, $800-$2000 per acre-foot. For comparison, the estimated cost of water from the Los Angeles Aqueduct that is being used for dust control is $323 per acre-foot. In addition to the type of source water, desalination costs will be influenced by proximity to distribution systems, and the availability and cost of power.

The California Coastal Commission (no date) states that, for every 100 gallons of seawater input, 15-50 gallons of fresh water is produced ("recovery" is 15 to 50 percent). The remainder is waste brine solution that must be discharged; seawater desalination produces a concentrate about twice as salty as seawater. Since Owens Lake brine can be up to 12.5 times as salty as seawater, its desalination might present technical problems that would signficantly increase costs beyond those for seawater desalination. The USEPA (2003) evaluated nine arsenic removal technologies considered "affordable" for small drinking water supply systems; most are more than 90 percent efficient in removing arsenic. However, most of them have specific optimal water quality conditions such as pH range, and some require concentrations of TDS, chloride, sulfate, or other constituents much lower than those observed at Owens Lake. If desalination were seriously considered as a local water supply at Owens Lake, it would probably be more feasible to treat and use the larger volume of deep ground water beneath the lakebed than the surface brine or brackish water.

Environmental issues. The importance of the surface waters of Owens Lake (including wetlands) as habitat for migratory birds and sensitive species is noted in Section 4.B., above. In comments on environmental documents for previous projects (e.g., GBUAPCD, 1997), staff of both the California Department of Fish and Game and the California State Lands Commission have emphasized the need to protect the natural and biological resources of Owens Lake. It would not be feasible to divert and use a substantial amount of surface water from the lake for municipal use without significant effects on wildlife habitat.

7. Conclusions and Recommendations

This staff report shows that the surface waters of Owens Lake historically had naturally poor quality, and that this poor quality has been aggravated for most remaining surface waters by the effects of diversions from the lake's tributaries. Surface water quality varies spatially and temporally, but drinking water standards and criteria are exceeded for one or more constituents at many monitoring sites. Surface water quantity is variable due to diversions, and to seasonal and annual variation in precipitation, runoff, and evapotranspiration; this would make surface water an unreliable source for municipal supply.

Other than anecdotal information about 19th century use of the water as a health tonic, there is no evidence of historical or existing (since 1975) human use of the surface waters of Owens Lake for drinking. There are no known plans to treat and use the surface waters of the lake for domestic supply. Treatment would probably be infeasible for technical and economic reasons. The limited surface water supplies are also in demand for environmental purposes including dust control and maintenance of wildlife habitat. Removal of the potential MUN use from Owens Lake is appropriate under state and federal regulatory guidance for changes in beneficial uses. Although some surface waters of the lake (springs, wells, and surface runoff) meet the Sources of Drinking Water Policy's 3000 mg/L TDS threshold, because of the potential for periodic flooding and mixing, the entire lakebed below the historic shoreline should be considered a single water body for purposes of beneficial use designations.

Removal of the MUN use would change the applicability of certain existing water quality objectives and waste discharge prohibitions to surface waters of Owens Lake, and would consequently affect the Regional Board's permitting and enforcement activities for discharges to these waters. Regionwide objectives and standards for protection of other designated beneficial uses of these waters would continue to apply. Some of these standards may not be appropriate for Owens Lake brine; for example, the USEPA's saltwater criteria and standards were developed for marine and estuarine organisms adapted to salinity much lower than that of Owens Lake. The Regional Board may wish to consider developing site specific objectives for Owens Lake, and/or biocriteria objectives for inland saline waters in general, at a later date when sufficient resources and biological monitoring data are available. In the meantime, the Basin Plan provides that water quality objectives apply only to controllable factors, and the Regional Board will continue to consider background water quality when setting discharge limits.

Regional Board adoption of staff's proposed changes to Table 2-1 of the Lahontan Basin Plan, to remove the MUN use from surface waters of Owens Lake, and clarify its application to wetlands above and below the historic shoreline, is recommended.

8. References

Citation of the following publications in this staff report is not meant to imply incorporation by reference.

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